GEOLOGY OF CHICKASAW COUNTY.

BY

SAMUEL CALVIN.

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INTRODUCTION.

GEOLOGIC AND GEOGRAPHIC RELATIONS—AREA.

Chickasaw county, one of the altogether too few geographical divisions which bear a name derived from the speech of the aboriginal inhabitants, is located in the northeastern part of the state. Howard county separates it from Minnesota, Winneshiek and Fayette bound it on the east, Bremer on the south and Floyd on the west. With respect to its indurated rocks, Chickasaw is wholly included within the Devonian area; so far as concerns its surficial deposits, it lies within the area occupied by Iowan drift. Its eastern boundary is located only a few miles west of the eastern edge of the Iowan plain, and as a result of its position our county embraces some of the sandy ridges, loess covered uplands and other marginal topographic characteristics of the Iowan area. There is only the width of two counties separating Chickasaw from the deep valley and the steep, rocky, picturesque bluffs of the Mississippi river; and much less space intervenes between our county and the driftless area with its streams flowing in deep gorges, the whole surface profoundly trenched and carved by erosion so as to expose rock sections scores or even hundreds of feet in height almost everywhere. To one not personally familiar with the facts, the contrast between the driftless area and the county we are considering is almost inconceivable; for Chick-

asaw county is an area of practically no rock exposures, it is a level plain, uneroded, in most of its area very imperfectly drained so far as being provided with natural trenches for carrying off storm waters is concerned. The area of Chickasaw county is approximately 500 square miles.

PREVIOUS GEOLOGICAL WORK.

The geologists of a generation ago gave very scant attention to the drift, or to any of the numerous problems connected with the surficial deposits. From the standpoint and attitude of that day these subjects were all negligible quantities which seemed scarcely to fall within the scope of geological science. For it must be remembered that geology was then confined almost exclusively to an investigation of the indurated rocks, of the sedimentary rocks chiefly—such as limestones, sandstones and shales—together with their fossil and mineralogical contents. With most of the prominent geological workers of the time there seemed but one sure way to win geological renown, and that was to describe new fossil species. When, therefore, it is borne in mind that more than nine-tenths of Chicaksaw county is simply a great prairie plain presenting nothing for investigation but such commonplace things as rich black soils and erratic crystalline bowlders, that exposures of native rocks are very few, and none of commanding interest from the point of view of the elder geologist, it will not seem strange that this county is scarcely mentioned in our geological literature. It was with reference to an area in northeastern Iowa, of which Chickasaw county is a typical part, that our pioneer geologist, Dr. David Dale Owen, wrote in his report to the Commissioner of the General Land Office, in 1848:—"The geologist who undertakes to investigate the vast prairie country of the Mississippi Valley must be provided with no common share of patience and perseverance. He must be content to travel for half a day together without seeing aught but a rich, black soil, covered, as far as the eye can reach, even down to the very edge of the small streams, with a thick and high growth of prairie grass, with perhaps a faint outline of timber cutting the distant horizon. He must be prepared to wade swamps, to ford streams waist deep, or, in times of freshets, to plunge in and

breast the current. He must not shrink beneath a broiling sun, without even a bush to cast a faint shadow over an occasional resting-place. He must think himself fortunate if he can reach, at night, a few scattered oaks to plenish his fire, and boil his camp kettle; and he may consider it a special instance of good luck, if, in return, he can catch a glimpse of a rock exposure once or twice a day. He may travel for days together without lighting on any object more interesting than the hillock of the prairie dog, or the broad lair of the bison."*

The conditions under which the work of D. D. Owen was done have long since disappeared. The aspect of the country has been greatly changed. Groves, everywhere, within the limits of the horizon, break up the wideness and monotony of the sea-like expanses of level prairie, fringes of planted trees afford grateful shade by every wayside, while improved roads and well constructed bridges relieve the traveller almost wholly from the necessity of wading marshes or fording streams. Many of the marshes, by well planned drainage, have indeed been transformed into fruitful fields. But amid all the transformations which have taken place since Owen worked and wrote, the scarcity of rock exposures remains practically unchanged. In Hall's report on the Geology of Iowa there is the barest reference to Chickasaw county, and that relates altogether to the drainage and surface characteristics.† White's report‡ does not even mention our county in any way. As a matter of fact, however, the serious limitations of time under which he worked prevented his visiting any of the prairie counties in northeastern Iowa. In McGee's Pleistocene History of Northeastern Iowa§ there are references to the topography and other surficial phenomena of Chickasaw county. In no official publication, however, has there heretofore been any discussion of the interesting though numerically limited rock exposures which the county affords.

*The quotation is copied from Owen's Geol. Sur. of Wis., Iowa and Min., p. 79; Philadelphia, 1852. The wording is but slightly different in the original report to the Commissioner of the Land Office, pp. 86 and 87; Washington, 1848.

† Rept. on the Geol. Surv. of the State of Iowa, by James Hall and J. D. Whitney; Vol. I, Part I, p. 306. 1858.

‡ Rept. on the Geol. Surv. of the State of Iowa, by Charles A. White, M. D.; Vols. I and II. Des Moines, 1870.

§ The Pleistocene History of Northeastern Iowa, by W J McGee; Eleventh Ann. Rept. of the U. S. Geol. Surv.; Washington, 1891.

PHYSIOGRAPHY.

TOPOGRAPHY.

The topography of Chickasaw county shows few striking features of any kind. In general the surface is a plain modified by only a small amount of relief. With the exception of some small areas in the western part of Bradford and Chickasaw townships, the whole county is covered with the Iowan drift which remains unaltered and uneroded, precisely as it was left at the time of the withdrawal of the Iowan glaciers (Fig. 22.). In places the Iowan drift mantle was thick enough to disguise the pre-Iowan topogra-

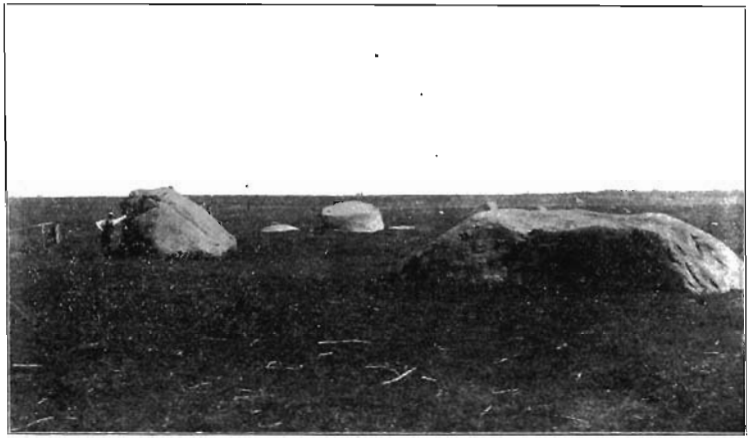

FIG. 32. Level Iowan plain with characteristic bowlders, southwest quarter of section 18, Dresden township.

phy and develop the typical, gently undulating Iowan plain. In places the latest drift was too thin to do more than slightly modify the older, erosional topography. An unusual number of streams traverse the county—the general trend being from northwest to southeast—and divide the surface into a corresponding number of long, narrow inter-stream areas. The streams follow

broad, shallow troughs in the surface, in places two, three, or four miles in width. The narrow divides between the broad valleys vary in topographic types from areas of pronounced hills and swells and minor irregularities, to upland plains diversified by only low, flat, long-sweeping undulations. The typical Iowan plain is exemplified in the northern part of the northern townships, Deerfield, Washington, Jacksonville, and Utica. New Hampton is located in the center of such a plain, and the same type of plain surrounds Ionia, stretching away to the horizon in nearly every direction. The gently undulating plain, developed by the constructive and moulding effects of glacial ice, and not by erosion, is the predominant type of topography throughout the county. There are a number of areas, especially in the eastern part of the county, so level that drainage is still very imperfect, and crops suffer accordingly when seasons are more than usually wet.

The hilly, rolling tracts are never very extensive, but they are met with more or less frequently in every part of the county. Such tracts have no definite boundaries, for, in very short distances sometimes, they fade out and blend into the characteristic Iowan plain. One of these belts of rolling country occurs two or three miles south and southeast of New Hampton. For a mile and a half east of Fredericksburg there is a low, level plain, and this is followed by an upland area broken into rounded hills which, in some instances, rise sixty feet above the intervening depressions. From such a station as the southeast corner of section 9, Fredericksburg township, the contrast between the low plain and the billowy upland is very strikingly illustrated. A score or more of similar examples might be given. There are, for instance, a few sections of rolling Iowan in the northeastern part of Bradford township and contiguous parts of Chickasaw. The northwestern and western parts of Richland township are comparatively level, but the surface breaks into rolling swells along Calamus creek, while a third phase of the Iowan topography is illustrated in the broad, flat bottom land, partly undrained, which borders the Wapsipinicon river a little farther east in the same township. The rather feebly developed hilly characteristics of the rolling Iowan are still further exemplified in the southeastern

FIG. 33. Border of a small area of "rolling Iowan" in the southwest quarter of section 15, Jacksonville township.

corner of Jacksonville township and the adjacent parts of New Hampton. But these may suffice for concrete illustrations of a type of topography easily recognized and quite widely distributed (Fig. 33). The hills in such areas are not high, the surface slopes are comparatively gentle, the topography has not been developed by erosion since the Iowan drift was deposited, neither can it be claimed that it is simply a modification of a pre-Iowan surface. Like the more level plains into which this type merges, it is a product of constructive agencies, of ice moulding.

In some parts of the county the pre-Iowan topography is but imperfectly concealed by the later drift. An area of this kind makes up the long slope between Devon and the Little Wapsipinicon river at North Washington. There was here deposited only a very meager amount of Iowan drift; the rain-cut gullies by the roadside reveal the leached and oxidized Kansan till and the ferruginous Kansan gravels within a few inches of the grass roots; the undulations of the surface are much stronger than in typical Iowan areas; the hills and trenches of the old eroded Kansan are clearly expressed in the modern topography. Another interesting bit of erosional pre-Iowan topography is seen along the line

which separates sections 20 and 29 in Bradford township, on the east side of the Cedar river, opposite Nashua. A rather deep ravine with short lateral gulches, preglacial as to age, is cut in the Devonian limestones. Over part of this area all drift is absent, the rock coming practically to the surface as shown in figure 34. On both sides of the Cedar river, from the point where this

FIG. 34. Quarry in the southeast quarter of section 20, Bradford township, showing absence of drift in a small area of pre-Iowan topography.

stream enters Bradford township to where it leaves the county near Pearl Rock, there is a general absence of drift of any age, the Devonian limestones crop out on the slopes and hill tops in numerous places, the hills and ravines, with reliefs of fully eighty feet, are a product of preglacial erosion working on the indurated rocks. In the angle between the Cedar river and the Little Cedar, near Bradford, there is a high, steep-sided promontory not drift-covered, a conspicuous illustration of some of the characteristics of the preglacial topography. On the west side of the Little Cedar river, between Bradford and Bassett, there is very little Iowan drift; there are places where there is practically no drift of any kind; the topography is of the older erosional type. A region of sandy and partially loess-covered hills sixty to eighty

feet in height, well carved by surface drainage, occurs in sections 16, 17, 20 and 21, Chickasaw township. There are deep trenches of recent erosion along the roadsides, and there are some rain-cut scars and gulches in the fields; but in general the topography is old, older than the Iowan stage of glaciation. In the northeastern part of the town of Bassett there is a prominent knob-like hill which is the south end of a narrow ridge jutting out from the upland Iowan plain and encroaching upon the low, broad valley of the Little Cedar river. The bluffs bordering the river valley rise to the same general level. The whole surface of the region—bottom lands, bluff slopes and upland plains—is sprinkled with Iowan bowlders. The Iowan ice was here, but the amount of detritus it carried was insufficient to affect in any notable degree the relative altitudes of the pre-Iowan bluffs and low lands.

In a region as level and monotonous as is Chickasaw county in general, the shallow stream valleys become marked features of the topography. Over most of the county these valleys are simply broad concave sags in the general surface; but the valley of the Cedar throughout its short course in Chickasaw, and the valley of the Little Cedar from above Bassett to its confluence with the larger stream, are evidently old, rock-cut, preglacial trenches bounded by bluffs and hills rising to heights of eighty feet or more. Very little of the material from any of the drift sheets covering the adjacent parts of the country found permanent lodgment in these valleys. Between the town of Chickasaw and Nashua the broad bottom lands through which the Little Cedar flows are underlain by a heavy body of the valley phase of the Buchanan gravels, showing that the valley was as wide and deep as it is today at the time of the melting of the Kansan ice. There has been no filling and re-excavation of these valleys since pre-Kansan time. Some ox-bow lakes or abandoned meanders in sections 4 and 9 of Bradford township, practically at the present level of the river, indicate that there has been no deepening of the valley in very recent periods. Above and below Jerico, in sections 28, 31 and 33 in the northern part of Jacksonville township (Tp. 97 N., R. XII W.), Crane creek flows in a broad, ill-drained bottom land which is set off from the drier upland by an imperfectly defined terrace slope. The terrace is composed of valley

gravels of the Buchanan stage. In this region there has been some erosion of the gravels in the long intervals since their deposition, deepening the valley in which the stream meanders, probably to the extent of eight or ten feet. There is a small amount of rock cutting in the valley of the Little Turkey river, beginning one-half mile above Little Turkey post office and continuing at intervals to where the stream leaves the county. This feature is most marked a short distance east of the center of section 25 in the southern part of Utica township.

In other parts of the county, as already indicated, the streams flow in broad shallow sags in the drift and do not differ from the ordinary valleys of the Iowan plain. A number of branches of the Wapsipinicon converge in the southern part of Dayton township, and hence there is here an unsually large area of low, flat land, some of it showing ponds, and all of it imperfect surface drainage. There are here, however, as usual along all the streams, extensive valley trains of Buchanan gravel, and these afford perfect underdrainage to quite a large part of the area, and render its cultivation possible even in the wettest of seasons.

DRAINAGE.

The great number of streams traversing the county from northwest to southeast and dividing the surface into a correspondingly large number of long, narrow inter-stream areas, has been previously noticed. The Cedar and the Little Cedar drain the southwestern part of the county; the wide central belt extending from northwest to southeast, is effectively drained by the numerous branches of the Wapsipinicon; while Crane creek and the Little Turkey river carry off the surplus waters from the northeastern area. All the main drainage courses, as is clearly indicated by the general presence of accompanying valley trains of Buchanan gravel, were outlined as early as the melting stage of the Kansan ice; while the deep, rock-cut valleys of the Cedar and the Little Cedar were partially or wholly developed in preglacial time.

Altitudes.—The following table, showing the relations of a number of the more important points in the county to sea level, is compiled from Gannett's Dictionary of Altitudes:

	FEET
Alta Vista	1,155
Devon	1,194
New Hampton	1,155
Fredericksburg	1,075
Nashua	981
Lawler	1,078
Bassett	1,017

An examination of the table reveals the interesting fact that though the direction of the streams is toward the southeast, the general slope of the county is toward the southwest. Fredericksburg, located in the valley of a branch of the Wapsipinicon, is 94 feet higher than Nashua, almost directly west of it in the valley of the Cedar; and Lawler, in the valley of Crane creek, is 61 feet higher than Bassett, which is in the same latitude in the valley of the Little Cedar. The high points, Devon and New Hampton, are located on one of the long, narrow dividing ridges.

This general slope of the surface toward the southwest is not peculiar to Chickasaw county, it is characteristic of the major part of all northeastern Iowa. The country rises toward the northeast until the high points within a few miles of the Mississippi river, such as Iron hill near Waukon, attain an altitude of 1,300 feet above the sea. This anomalous behavior of the streams in flowing, not with the slope, but at right angles to it, was years ago pointed out by McGee in his Pleistocene History of Northeastern Iowa.*

STRATIGRAPHY.

SYNOPSIS.

The geological formations exposed in Chickasaw county are few in number. They are limited to two systems, the Devonian and the Pleistocene. The indurated rocks may all be referred to the Cedar Valley stage of the Middle Devonian series; the surficial clays and soils accessible to observation belong almost exclusively to the Kansan and Iowan stages of the Glacial series. The pre-Kansan drift exists, without much doubt, in its proper place at the base of the Pleistocene deposits, but its presence is not positively known. It is justly inferred, however, from the

* Eleventh Ann. Rep., U. S. Geol. Surv., pp. 363-365.

fact that a forest bed is encountered, interstratified with glacial deposits, in drilling deep farm wells in various parts of the county.

The stratigraphic relations of the formations which are open to direct investigation in Chickasaw county, may be conveniently indicated in tabular form as follows:

GROUP.	SYSTEM.	SERIES.	STAGE.
Cenozoic.	Pleistocene.	Glacial.	Iowan.
			Kansan.
Paleozoic.	Devonian.	Middle Devonian.	Cedar Valley.

Devonian System.

General Discussion.—So far as known the Devonian limestones underlie the Pleistocene deposits over the entire region now under consideration. Chickasaw county, however, is so generally and so completely covered with glacial drift that rock exposures are very few in number and very widely scattered. There is one very obscure outcrop of Devonian limestone on Crane creek, and two or three, somewhat more satisfactory, occur on the Little Turkey river in the southeastern part of Utica township. All the other outcrops are in the western part of the county, and the most important of these are confined to the valleys of the Cedar and the Little Cedar rivers. In seven townships out of the twelve there is not a single exposure of native rocks in place, and over almost the whole area of the remaining five, the surface is fertile prairie with the native Devonian beds concealed by deep deposits of drift.

The strata exposed in the county range from the horizon of *Gypidula comis* and *Spirifer pennatus,* the equivalent of the quarry beds at Independence, to the horizon of the yellow, magnesian limestones which lie above the Acervularia and Stromatopora zones and form the uppermost members of the Devonian sections in Buchanan and Howard counties. The beds are more or less magnesian throughout the entire section, and some parts

of the section are so completely dolomitized as to resemble certain phases of the Niagara limestone in the counties of Delaware and Dubuque. The resemblance to the Niagara is heightened when, as occurs in a quarry nearly opposite the mill at the town of Chickasaw, the heavy, dolomitized beds include great numbers of chert nodules and are separated one from the other by thick bands of chert. In nearly all the exposures of the Devonian in this county the limestone is soft, earthy, granular and non-crystalline, and vug-like cavities lined with calcite are common. In quarrying some of the beds the lining of calcite becomes detached from the wall of the cavity in which it was deposited and furnishes an example of a thin-walled, calcareous geode.

Typical Exposures.—Gypidula comis Beds, the lowest beds recognized in the county are seen in the east bluff of the stream,

FIG. 35. Quar y in cherty dolomitic beds at the *Gypidula comis* horizon, a short distance above the bridge at Chickasaw.

a few rods above the wagon bridge at Chickasaw (Fig. 35). There is a section of twenty-five feet here exposed. The rock is a heavy bedded dolomite which is much broken up toward the sur-

face on account of weathering. Lower down the beds are intersected by numerous joints. A large amount of chert in streaks and bands—the chert sometimes included in the layers, in some cases occurring as partings between them—is a striking feature of this section, and one very unusual in the Devonian. Lithologically and otherwise the rocks resemble very closely many exposures of the Niagara in Delaware, Jones and Dubuque counties. At first sight it seemed scarcely possible that such rocks could belong anywhere except in the Niagara; but, while fossils are absent from most of the beds and are scarce in all of them, it was found that the lower ledge, about three feet in thickness, contained many perfect casts of *Gypidula comis* Owen, and *Spirifer pennatus* Owen. These species establish the Devonian age of the beds beyond question and make it possible to correlate them with the beds in the City quarry and the lower part of the O'Toole quarry at Independence. The differences, however, in the character of the stone and in the firmness and thickness of the individual layers at the two points, Chickasaw and Independence, are surprisingly great. The beds described above crop out at intervals for some distance along the bluff, above and below the quarry shown in figure 35, and they have been cut through by a deep ravine which traverses the southeast ¼ of section 16, a short distance north of the quarry.

On the west side of the river, about a mile above the bridge at Chickasaw, beds of about the same horizon as those in the Chickasaw quarry are exposed in a ravine, near the level of the water in the stream, not far from the middle of the north line of the southwest ¼ of section 16. Quite an amount of building stone has been taken out at this point and the locality is known as the Huffman quarry. The stone is magnesian, but is not so perfectly dolomitized as at Chickasaw. The layers are thinner and the fossils, instead of occurring as mere casts, have the shells preserved. The finely striated Independence type of *Atrypa reticularis* is common, and there are some specimens of *Spirifer pennatus,* a form always associated with the preceding at the typical outcrops in Buchanan county.

Atrypa occidentalis Beds. Beds a little higher in the geologic column than those described in the preceding paragraphs, are

seen in the old Bishop quarry (Fig. 36), in the northeast ¼ of section 16, Chickasaw township. The stone, as usual in this part of Iowa, is highly magnesian and lies in thin, even layers which may be quarried in flagstone-like pieces two to six inches in thickness. There are numerous cavities lined with calcite, and some very

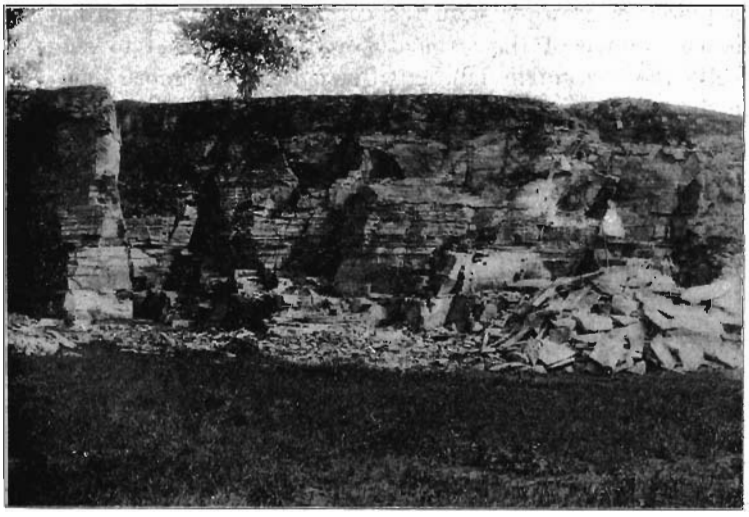

FIG. 36. The old Bishop quarry at the horizon of *Atrypa occidentalis*. The Acervularia beds are seen at the top of the section.

perfect and symmetrical calcareous geodes may be obtained as a result of the separation of the calcite lining from the walls of the cavities. The fossils are of the types found toward the upper part of the quarries at Independence, and include along with *Atrypa reticularis* and *Spirifer pennatus*, such forms as *Orthis iowensis* and Hall's occidental variety of *Atrypa aspera*. The beds are cut by oblique, parallel joints, shown in figure 36, and along the joints the fossils are often well exposed by solution and removal of the matrix.

Acervularia profunda Beds. This zone occurs at the top of the Bishop quarry as it does in most of the quarries at Independence, overlying the *Atrypa* and *Spirifer pennatus* zones. Besides the typical species, *Acervularia profunda*, this zone contains *Cystiphyllum americanum, Favosites alpenensis, Cladopora prolifera*

and a number of the coarse stromatoporoids which are associated with these species at the same geological horizon at Littleton in Buchanan county. Here, as at Littleton, the *A. profunda* shows a conspicuous tendency to independent growth of the corrallites. The quarry exposes a section twenty feet in thickness. The upper two and a half feet are occupied by the Acervularia zone, which in places is crowded with the corals and stromatoporoids mentioned. Some of the stromatoporoids, weathered to show perfectly the concentric, laminated structure, are more than a foot in diameter.

The beds immediately below the Acervularia and stromatoporoid horizon are quarried and burned for lime in the town of Chickasaw, at a point thirty-five feet higher than the base of the quarry in the river bluff near the mill. The Acervularia zone is included in the stripping. The corals are large and coarse. Stromatoporoids are most common; but Acervularia, Cystiphyllum, Zaphrentis, Cyathophyllum, and a form that is probbaly Craspedophyllum are also present. The corals are all more or less silicified, and the entire zone is useless for lime burning.

The Acervularia horizon, noted above, is indicated in the pits made for the foundations of the new railway bridge at Nashua. Among other species recognized in the loose materials thrown out in making the excavations were *Acervularia profunda, Stropheodonta demissa* and *Orthis iowensis*. Below the Greenwood mill, one mile northeast of Nashua, loose fragments of rock evidently washed out of the river bed by the plunge of water over the dam, contained a number of stromatoporoids besides *Acervularia profunda, Craspedophyllum strictum, Atrypa reticularis, A. aspera*, and other types belonging to the horizon of the quarries at Chickasaw. The beds which at Chickasaw are at least thirty-five feet above the river, are at Nashua and Greenwood mills below the level of the water. The slope of the valley, ascertained by comparing the altitude of Nashua with that of Bassett, is about four and one-half feet to the mile. From Chickasaw to Nashua the fall should be about twenty-seven feet. Between these two points the Acervularia zone has descended from at least thirty-five feet above, to five feet below the level of the water, making a total dip to the strata of about eleven feet to the mile.

Spirifer parryanus Beds. Above the mill dam at Nashua there are exposures in the right bank of the Cedar river showing a section twenty-five feet in thickness. The layers are not all well exposed, but so far as they could be observed they are soft, earthy dolomite. The lower part of the section is quite barren of fossils, but twenty feet above the level of the water there are a few layers rich in casts of *Spirifer parryanus* Hall. At Littleton, Iowa, the *S. parryanus* horizon is not more than five or six feet above the *Acervularia profunda* beds; at Nashua the two horizons are separated by more than twenty feet of comparatively barren strata. While in the river bluff at Nashua the fossils appear only as casts, there is evidence that non-dolomitized beds of this horizon must outcrop somewhere in the neighborhood. In making a small culvert in one of the streets of the city, slabs of a comparatively pure limestone were used, in which the crowded shells of *Spirifer parryanus* are perfectly preserved. Information as to where the stone came from could not be obtained; but great variations in the lithological characteristics of any given stratum, within very short distances, are by no means unusual. The *S. parryanus* beds descend to the level of the water at Pearl Rock, three miles south of Nashua, the dip south of the city being essentially the same as that from the north, eleven or twelve feet to the mile.

Idiostroma Beds. In a ravine a short distance north and west of the Thomas school house, in the southeast ¼ of section 30, Bradford township, there are two parallel ridges or reefs of the coarse-stemmed Idiostroma which occurs from ten to fifteen feet above the *Spirifer parryanus* horizon in Johnson county. These reefs are curiously local affairs. Each one is only thirty or forty feet in width, thickened in the middle and thinning out at the edges. They are about twenty yards apart, and their trend is northwest-southeast. They are underlain and overlain by soft, earthy dolomite, the overlying beds arching over the ridges, dipping in between them, and coming on each side in contact with the underlying beds. They seem to be simply elongated lenses of reef material with no very great extension in any direction. On the west side of the ravine, a little below the point where the reefs occur, there is a good section which includes both the underlying and the overlying beds, but it shows no trace whatever of the

Idiostroma material. The whole body of the reefs has been altered more or less to a very hard, light-colored, siliceous dolomite, very different in texture, color and composition from the soft, granular beds prevailing in this vicinity. The surface of the tangled mass of Idiostroma stems is covered in places with a thin coating of quartz, and in the more compact portions of the mass, minute quartz crystals line the surface of cavities from which fossils have been dissolved. In addition to the Idiostroma, which is the common and typical fossil, there are occasional specimens of *Acervularia davidsoni*. A Favosites, probably *F. alpenensis*, occurs more frequently. *Euomphalus cyclostomus* Hall, a form always associated with Idiostroma in Johnson county, and a slender Orthoceras six or eight inches long, are among the other observed fossils. The great alterations which the reef material has undergone, has made specific identification of the unsatisfactory casts by which fossils are mainly represented, in some cases practically impossible. While these local ridges of Idiostroma and associated fossils are in their proper stratigraphic relations to the other known life zones of the Devonian, it is quite evident that this particular area was never occupied by a living Idiostroma reef such as once covered the region now known as Johnson county. Such reef material does not appear anywhere else in Chickasaw county, although there are many sections, some, as noted above, within even a few rods of the locality described, which embrace strata from geologic levels both above and below the reef horizon. At present there is no known point nearer than the northern part of Johnson county where this peculiar stromatoporoid on a reef-making scale flourished in place. The very limited extent of the Idiostroma lenses, their relations to the regular sediments of the region, and their lithological differences from the local strata, all suggest that the relatively small amount of material they represent was brought here from probably long distance by some marine agent of transportation.

Lithographic Beds. At Iowa City there are beds of fine-grained, light-gray lithographic limestone beginning a few feet above the Idiostroma horizon. Similar beds have been noted in this volume above the equivalent of the *Acervularia davidsoni*

zone in Howard county. They occur in the same geological position at numerous other points in Iowa. They are present on the hill tops about Nashua in Chickasaw county. There are no sections in this county that show the lithographic beds well, but some weathered ledges in place and numerous loose fragments may be seen on the high points in the roads leading north and south from Nashua.

Intermediate Beds. To horizons somewhere between the *Spirifer parryanus,* and the lithographic beds should be referred the exposures in the northern half of Deerfield township. The entire absence of fossils here makes exact correlations difficult, but the lithological resemblance of the beds to the thin layers in the upper part of the Croft quarry at Elma in Howard county, coupled with the fact that the Deerfield exposures are distant from Elma only a few miles, would justify the reference of these beds to the horizon of the upper part of the Elma quarries, or to one slightly higher. As a matter of fact beds corresponding to those in the upper part of the Elma quarries have been worked four miles southwest of Elma, within less than two miles of some of the exposures in Deerfield township, Chickasaw county. By reference to the Howard county report it will be noted that the *Spirifer parryanus* zone is present in the bottom of the Croft quarry, and hence the beds in question lie between this zone and the horizon of the lithographic limestone.

In the southeast ¼ of section 3, Deerfield township (Tp. 96 N., R. XIV W.), on land belonging to Edward Brown, stone has been quarried somewhat extensively to meet the local demand. The beds are thin, yellowish, argillaceous, and without fossils. Toward the bottom of the quarry the bedding is quite irregular, and below the bottom as it appears at present, from a pit now filled with mud, there were formerly quarried a few ledges of hard limestone, six to eight inches in thickness. There are here two openings a short distance apart. In both there is quite a strong dip toward the southwest. In the one farthest east the following section may be made out:

		FEET.
7.	Black loam mixed with weathered fragments of limestone	2
6.	Thin-bedded, earthy limestone, badly weathered, becoming thicker toward the west end of the quarry	3
5.	Band of harder, purer, drab-colored, crystalline limestone which is not affected by weathering	⅔
4.	Thin-bedded zone which disintegrates into a light yellow, marly clay mixed with concretionary nodules	2
3.	Thin, laminated, argillaceous beds, yellow in color, containing some fine siliceous grit	4
2.	Harder, dark gray beds which now form the floor of the quarry, layers six to ten inches in thickness, dipping southwest, upper surface irregular and uneven	2
1.	Heavy, hard beds, not now exposed, but were formerly qurried over a small area	3

A few rods to the southwest is the second opening which includes the same beds as the quarry just described, and shows in addition some firm beds of good quality above No. 6 of the preceding section. A mile and a half north of the Brown quarry, near the middle of the south line of section 27, Tp. 97 N., R. XIV W., on land of John W. Kane, there is a quarry which shows a series of beds probably equivalent to those above No. 6 in the second opening on the land of Mr. Brown. Some of the layers are hard, bluish in color, and from two and a half to three inches in thickness. In general the beds are thin, but toward the bottom of the exposed section there are some four-inch courses which may be made to serve a good purpose for such masonry as the neighborhood requires. Two miles farther north, near the middle of the north line of section 22 of the same range and township, the Tierney quarry is opened in a knob-like, stony point. The stone is the same as at the Kane quarry. Very little work has been done here in recent years.

To the same horizon as the exposures in Deerfield township, should probably be referred the two quarries which have been opened in section 4, Chickasaw township. One of these is in the northeast, and the other in the northwest ¼ of the section. The greatest amount of work has been done in the northeast quarry. As usual at this horizon, in this part of the state, the beds are thin. They are quite magnesian, but not truly dolomitic. Toward

the bottom the layers are thicker and stone of fair quality may be obtained. The strata are here cut by two systems of joints trending nearly east-west and north-south. As in all the magnesian beds of the region, there are some cavities lined with calcite.

The exposures so far discussed under the head of *Intermediate Beds,* are all on high ground as compared with those in the river valley at Chickasaw and farther south, but at an altitude from thirty to forty feet above the level of the river, in the southeast ¼ of section 20, Bradford township, there are two openings belonging to the Intermediate Beds. These probably lie a little below the floor of the Brown and Kane quarries in Deerfield township. One of these openings is shown in figure 34. The beds are thin in the upper part of the exposure, but there are some heavier ledges near the base. All the layers are more or less magnesian. Formerly these quarries were regularly worked, and some of the firmer and purer beds were burned into lime, but no work has been done here in recent years. What is known as the Allen quarry, two and three-fourths miles northwest of Nashua in Floyd county, is operated in these same beds, and from this the following detailed section is obtained:

		FEET.
6.	Thin-bedded limestone, the courses varying from one to five inches in thickness, some layers soft and granular, others hard and fine-grained.....	8
5.	Some firmer courses, six inches in thickness.....	2½
4.	An eight inch ledge of good building stone.....	⅔
3.	A firm fourteen inch ledge	1⅙
2.	A twelve inch ledge.....	1
1.	Heavy stone suitable for bridge work.....	1½

The order of succession is partly obscured by waste and weathering in the quarries in section 20 east of Nashua, but so far as it could be determined it is identical with that in the Allen quarry. There are few recognizable fossils at either of these points, the only forms seen were casts of *Atrypa reticularis* in the lower heavy ledges. Stone of the fine-grained, lithographic type crops out in the road about half way between Nashua and the Allen quarry.

The Upper, Yellow, Magnesian Beds. In the northwest corner of the town plat of Nashua, there are heavy, dolomitic layers above

the level of the lithographic stone seen in the road a short distance to the northwest. This is evidently the equivalent of the thick, magnesian layers in the upper part of the Salisbury quarry and the other quarries about Vernon Springs and Cresco, described in the report on Howard county, the equivalent also of the yellow magnesian beds quarried in the river bluffs above Littleton in Buchanan county, and of the beds quarried near Raymond in Blackhawk.

These beds are not well developed in the western part of Chickasaw, but they are seen to fairly good advantage on the other side of the county. The best and practically the only section in this region occurs in the west bluff of the Little Cedar river, near the center of section 25 in the southern part of Utica township. There is here a section ranging from fifteen to twenty feet in thickness. The rock is checked by numerous joints, the thickness of the beds varies from six or eight, to twenty inches, or even more. The rock is soft, yellow, magnesian, but durable and capable of affording a fair quality of ashlar and dimension stone. It has the concretionary or concentric iron staining of the corresponding beds in eastern Howard county, and there are the same vug-like cavities with calcite lining. Some impressions of coarse-ribbed Atrypas occur in some of the beds near the top of the section. At the bridge a short distance west of Little Turkey postoffice the same beds are exposed, and there are other exposures one-fourth of a mile above the bridge. Only one exposure was noted on Crane creek, and that was in the northwest ¼ of the northwest ¼ of section 13, Jacksonville township. Weathered fragments of a soft, magnesian limestone were all that could be seen. It is probable, however, that the horizon is the same as that of the beds on the Little Turkey in Utica township.

GENERAL DEVONIAN SECTION.

The probable thickness of the several members of the Devonian section in Chickasaw county may be expressed as follows:

		FEET.
7.	Upper magnesian beds	50
6.	Lithographic beds	10
5.	Intermediate beds	25
4.	Idiostroma beds	5
3.	Parryanus beds, and down to next division	25
2.	Acervularia beds	5
1.	Gypidula, and Atrypa beds, up to Acervularia zone	45

Pleistocene System.

KANSAN STAGE.

Kansan Drift.—There is reason to believe that the Kansan drift underlies the whole of Chickasaw county. It has been almost completely covered by the later drift of the Iowan stage, but in the rain-cut gullies by the roadsides it is revealed at many widely separated localities. It is shown in scores of well sections, and the new work on the Great Western railway has led to the making of many cuts in which the Kansan appears. The new railway cuts southeast of New Hampton all show the relation of the blue Kansan till to the overlying yellow Iowan. In one of the cuts about two miles from New Hampton the stratified sands and gravels of the Buchanan substage lie between the Iowan and the Kansan. In some places the yellow Iowan till rests on undisturbed rusty gravels, and the line of separation is sharply defined; in other places the gravel has been worked up into the Iowan, in which case it is not easy to recognize the exact limits of the two formations. In general the unweathered Kansan is blue in color. It is also quite calcareous. There are many limestone pebbles embedded in the till, but greenstone fragments are more common. There are places, however, in the fresh railway cuts where the Kansan is almost black owing to the presence of a large amount of organic matter. Splintered fragments of branches and trunks of trees are conspicuous in most fresh sections, the remains of forests that occupied the state during the Aftonian interglacial interval, and were overwhelmed, broken, rolled, crushed and worked up into the subglacial till by the advancing glaciers of the Kansan stage. The exposed surface of the Kansan was weathered, leached, oxidized and reddened during the intervals between the withdrawal of the Kansan ice and

the advent of the Iowan. The roadside cuts show a number of places where the material of this leached and reddened ferretto zone has been worked into the Iowan till in such a way as to make the drawing of a sharp line of division impossible. The fresh, unmixed Iowan is quite calcareous, the Kansan ferretto is completely leached, the mixture of ferretto and Iowan responds feebly to the acid test.

While the Kansan drift was exposed to meteorologic agencies in the intervals between the close of the Kansan stage and the beginning of the Iowan, the surface was at times washed and beaten by rains and at other times was affected by winds in such a way as to remove quite an amount of the fine surface clay, leaving the contained pebbles and cobble stones as a sheet of gravel of varying thickness, conforming to all the inequalities of the eroded surface. This fact is discussed in the reports on Page, Howard and Tama counties. West of Devon in Chickasaw county the Iowa drift is thin. The old surface of the Kansan was not greatly disturbed by the action of the Iowan glaciers. The weathered ferretto zone of the older drift and the more or less perfect sheet of residual or concentrated gravels which covered the old pre-Iowan surface, are shown in the roadway, or in the deeper trenches by the side of the road, between Devon and North Washington.

Buchanan Gravels.—The great sheets and trains of gravel which were deposited as outwash at the time the Kansan ice was melting and gradually withdrawing from this part of Iowa, are very generally distributed. Like the surface of the exposed till, these deposits suffered from the effects of weathering during the very long intervals preceding the coming of the Iowa glaciers and the distribution of the Iowan till. The gravels are red and rusty, and all feldspar-bearing fragments of the transported rocks are rotted, decayed, disintegrated. As in Howard, Buchanan and other counties in northeastern Iowa, there are here two phases of the gravels, the upland phase and the valley phase. In the upland phase, which occurs on the higher areas, the beds are quite heterogenous in that they are composed of fine sand, pebbles, cobbles, and small bowlders ranging up to a foot in diameter. The valley phase is made up mostly of small polished quartz pebbles,

with little or no sand, and without the larger cobbles and bowlders. The mode of origin and deposition of the two types of gravel deposits is discussed in the report on Howard county.

A number of deposits of very typical, ferruginous, upland gravels occur in and around New Hampton. The foundation for the extension of the German Catholic church was excavated in such gravels. A very characteristic bed is seen at the creamery, one-fourth of a mile south of the Great Western railway station. The gravels are very deeply stained with iron rust, the iron constituents being completely oxidized. Some parts of the beds are wholly or partially cemented into a conglomerate by the re-deposition of the ferric oxide, and there are many hollow clay ironstones, the result of secondary concretionary processes. There are the usual decayed granites and other feldspathic rocks ready to crumble to minute fragments when removed from their surroundings, and there are also some hard, undecayed cobblestones which retain the glacial striæ. The bed was cut through in grading for the railway, and a section ten feet in thickness is exposed. Less than one-half mile farther south the railway has cut through another and more extensive bed of the same oxidized gravels in which are found all the charactistics of the upland phase. At this point the deposit forms an esker-like ridge, and east of the railroad there is a very large pit from which material has been taken and used in the improvement of the adjacent streets and roads. It is almost universally the case throughout northeastern Iowa that the lower part of deposits of upland gravels is made up of cross-bedded sands, while the coarser materials—the pebbles, cobbles and bowlders—are found only in the upper part of the section. This feature is very strikingly illustrated in the pit last mentioned. There is another large gravel pit at New Hampton two or three hundred yards west of the railway and south of the creamery. There is not the usual amount of coarse material in the upper part of this exposure; erosion may have carried it away; the excessive staining of the sand in the pit would indicate that such material had once been present in its ordinary position, for pure quartz sand could not furnish anything which, by oxidation, would give rise to ferruginous stains. At this point there is no Iowan drift overlying the deposit.

Two miles southeast of New Hampton there are some new cuts which show a comparatively thin sheet of Buchanan gravels lying between beds of blue Kansan, and yellow Iowan drift. At one point the Iowan till arches over a low, narrow ridge of the gravels. Farther on, the Buchanan deposit becomes thicker, and the bottom of the cut, occupied by the sandy phase of the formation, is above the surface of the Kansan drift.

It is not necessary, nor would it be profitable, to mention all the observed exposures of the upland gravels. From descriptions already given any one interested will be able to recognize these

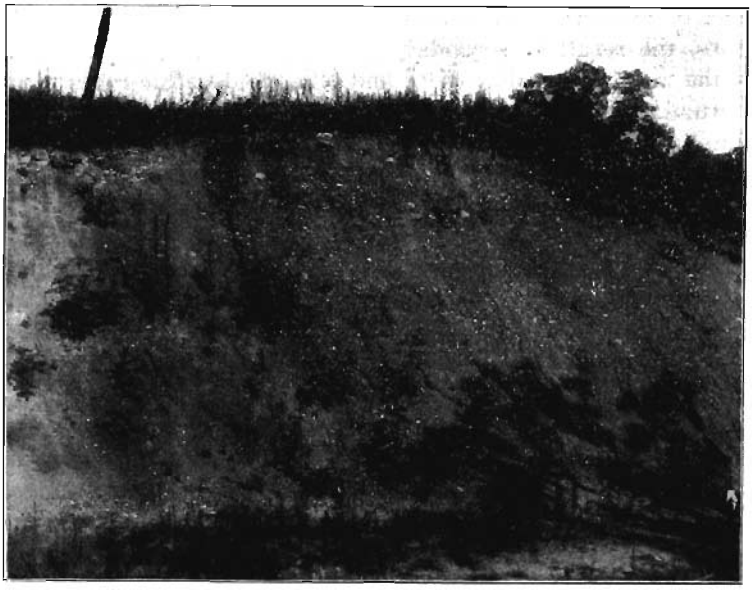

FIG. 37. Exposure of the upland phase of the Buchanan gravels at the north end of Brasher street, Nashua.

beds at sight. For the purpose merely of indicating their general distribution, reference may be made to a typical section in a road cut, on the west side of the southwest ¼ of the southwest ¼ of section 3, Fredericksburg township, and to another near the opposite corner of the county, in the southeast ¼ of the southeast ¼ of section 21, in the northern part of Deerfield township,

within less than a mile of the Howard county line. Another excellent example occurs in a cut made for the wagon road through a high ridge near the southeast corner of the northeast ¼ of section 9, Chickasaw township. This is probably the thickest deposit of the gravels found in the county. Near the bottom of the hill there are a number of small springs and seeps, presumably at the line of contact of the gravels with the underlying Kansan clay. On the upland one-half mile east of Chickasaw there is a pit deserving notice for the reason that from it has been taken the material for making one of the best pieces of road in the county, that between Ionia and Chickasaw. An exposure of the upland type of gravels is seen in an unusual position at the north end of Brasher street in the city of Nashua (Fig. 27). The bed occurs only a few feet above the level of the Cedar river, and yet it shows none of the characteristics of the valley phase of these deposits.

The valley gravels are so universally distributed along all streams that it seems scarcely necessary to do more in discussing their distribution than simply to mention the fact. There are extensive deposits about Lawler. Farther up Crane creek the valley gravels take the form of fairly well defined terraces, as near Jerico in Jacksonville township. Along the Little Cedar from above Bassett to Bradford there is an almost continuous sheet of gravel covering the bottom of the valley. The broad bottom lands through which the converging branches of the Wapsipinicon flow in Dayton township, are underlain with gravel which affords perfect underdrainage to what would otherwise be wet and swampy land. It will be sufficient to say that every stream course of any consequence has its valley trains, and that no part of the county is far removed from an abundance of the best possible materials for the improvement of the country roads.

IOWAN STAGE.

Iowan Drift.—With the exception of some sandy hills along the Little Cedar river, west and southwest of Chickasaw, the Iowan drift is spread as a practically continuous mantle over the entire county. In many places this mantle is very thin, and in no place is it known to attain a very great thickness. The yellow cal-

careous clay of the Iowan is readily distinguished from the blue clay of the fresh, unweathered Kansan, and it is not likely to be confused with the red or brown weathered and oxidized zone of the older till. For facts bearing on questions of the relative age of the two deposits, see the report on Howard county. The Iowan drift is not so pebbly as the Kansan. Its transported rocks take the form of large bowlders, very much larger on an average than anything appearing in the Kansan. Furthermore, these bowlders are coarse granites of types altogether unknown in the older drift. Chickasaw county has been favored with an unusual number of

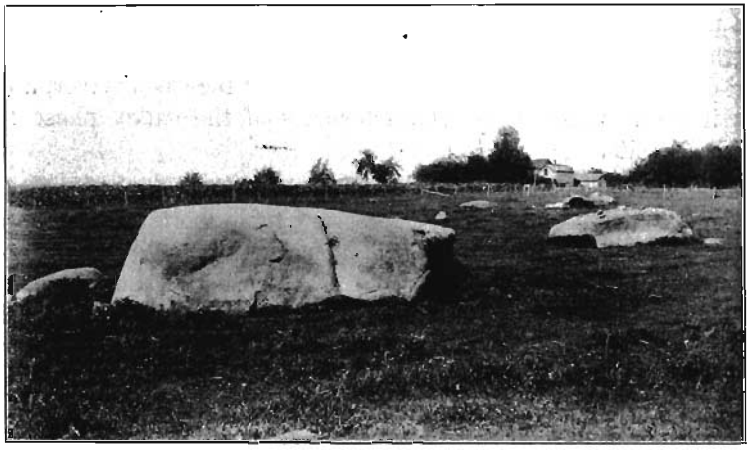

FIG. 38. Typical field of Iowan bowlders in the southwest quarter of section 18, Dresden township.

these erratic masses of granite (Fig. 38). It is doubtful whether any other county in Iowa is so well supplied. The value and amount of the high grade building stone which the Iowan glaciers carried from the north and deposited in this county are well nigh incalculable. There is an unusual area, small in size, about a mile and a half south of Bassett, in the southeast ¼ of section 17, Chickasaw township, where the surface is sprinkled with bowlders a foot or two in diameter, in a way resembling some portions of New England or New York (Fig. 39). But in general the rocks transported by the Iowan ice were brought in large masses, ten, fifteen or twenty feet in diameter. While in the aggregate, there-

fore, the mass is very great, almost beyond computation, the individual bowlders are rarely so numerous as seriously to encumber the surface. The largest of the many large bowlders seen in the

FIG. 39. Field showing an unusual number of small bowlders, in the southeast quarter of section 17, Chickasaw township.

county is that known as Saint Peter, located in the southwest ¼ of section 3, near the center of Washington township. The view (Fig. 40) shows that great mass of granite as it was seen from a distance rising out of a tall and rank growth of oats. Saint Peter is fully twenty feet in height and more than eighty feet in circumference.

A large proportion of the Iowan bowlders lie on or near the surface as shown in figures, 32, 38, 39 and 40. This fact has led some prominent geologists to the hasty and untenable conclusion that they were transported on top of the ice as part of an accumulation of superglacial drift. It must, however, be evident to any one who thinks seriously about the matter that a continental ice sheet, like the Iowan, would be, like the ice cap of Greenland, wholly free from superficial detritus. Valley glaciers, like those

of the Alps, may become loaded with superficial material; and a piedmont glacier, like the Malaspina, made up of confluent mountain glaciers carrying medial moraines, might gather sufficient detritus on its surface to support a vigorously growing forest; but the possibility of any considerable amount of superficial drift on a continental glacier is too small to be seriously considered. That the bowlders of the Iowan drift were not super-

FIG. 40. Saint Peter, the largest bowlder in Chickasaw county, as seen from a distance rising out of a heavy growth of small grain. southwest quarter of section 3, Washington township.

glacial is abundantly attested by the fact that a very large proportion of them are planed and scored on one or more sides as shown in figure 41. Some of the very largest and most prominent of them have been broken up into blocks for building stone, and in every case the lower side has been found to be planed and worn by being dragged along underneath the ice. The Iowan bowlders are now on the surface for the reason, largely, that the Iowan glaciers carried a comparatively small amount of clay and other fine detrital material, and therefore the thickness of the Iowan drift sheet is not sufficient to conceal the great blocks of granite which were embedded in the lower surface of the ice.

FIG. 41. Glacial planing on an Iowan bowlder, a common feature of Iowan bowlders, and one showing they were not superglacial.

Data bearing on the thickness of the Pleistocene deposits will be given below in connection with the discussion of wells and water supplies.

Soils.

The soils of our territory show but little variety. Over most of the county the soil is a rich, deep, black loam developed on the Iowan drift. Some portions of the Iowan surface is not well drained and in certain seasons the soil is wet and heavy, but such areas are admirably adapted to the growth of some kinds of meadow grasses. There is very little of the county, however, that cannot be cultivated successfully in years of normal rainfall. The warm, black, fertile loam developed on the Iowan till, and very much the same wherever this drift is spread, is one of the most desirable, the most productive, the most inexhaustible of the soil types found in our great state.

In the broad sags which serve throughout most of the county for river valleys, extensive sheets of the valley phase of Buchanan gravels are present as a subsoil and afford perfect underdrainage to large areas which would otherwise be too wet for cultivation. On the hills about Nashua the soil is thin, the Devonian limestones coming near the surface. There is a small area of sandy

soil on the erosional hills west of the Little Cedar river, in sections 20 and 21, Chickasaw township. On the whole there is no part of the state more favored in the matter of soils than Chickasaw county.

ECONOMIC PRODUCTS.

Apart from the splendid soils of the county there are no geological deposits capable of supporting extensive industries. The quarries furnishing building stone have been individually described in the discussion of the Devonian. The most important quarries are those in Chickasaw and Bradford townships, for these are most favorably located with reference to markets; but probably the best grade of limestone occurring in the county is that seen near the center of section 25, in the southeast corner of Utica township. The old Bishop quarry (Fig. 36) might be made to yield a good quality of flagging stone. The immense amount of granite in the surface bowlders of the county constitute supplies of building material, ready to hand, which will be appreciated and utilized more and more as there is increased demand for substantial structures of every kind. The larger bowlders, as veritable granite quarries, will be systematically attacked with the best modern quarrying tools and broken into properly shaped blocks for bridge piers and heavy foundations.

Mr. Marion E. Ackley operates lime kilns at Chickasaw and supplies the local market with a product of excellent quality. It is the beds immediately below the Acervularia and stromatoporoid horizon that are used in lime burning. Lime was formerly made from the same beds at the old Bishop quarry, about a mile north of Chickasaw. Another lime kiln, which, however, has not been used for some years, is located in the southeast ¼ of section 20, Bradford township.

There is no limit to the amount of drift clays occurring in Chickasaw county, but clays suitable for the manufacture of brick and tile are not common. The objectionable feature in the drift clays is the great number of pebbles which are universally present. The blue Kansan till contains numerous limestone fragments which, even if the other pebbles could be disposed of, would effectually bar its use for the manufacture of clay products. The

Iowan clay is less objectionable than the Kansan on account of its practical freedom from pebbles of limestone. The only brick yard seen in the county is that operated by Mr. Cotant about three-fourths of a mile west of New Hampton. The clay used is the upper three feet of the Iowan drift, most of it the fine black surface loam or soil. The raw product is dried partly in the sun, partly on pallets under cover. The burning is done in small clamp kilns, with a capacity of 100,000 for each kiln. The plant includes a two horse-power, Iron Quaker machine of 20,000 daily capacity.

In the matter of road materials, the limestones may properly be counted among the available deposits; but the Buchanan gravels, both in their upland and valley phases, constitute by far the most important resources of the county in this direction. The siliceous pebbles mixed with a small amount of sand, just as they occur in most of the native beds, make an ideal road dressing. The material is cheap and, by reason of the wide distribution already described, it is everywhere at hand. The fine piece of road between Ionia and Chickasaw, and that leading south from New Hampton to Williamston, are impressive object lessons on the subject of what may be accomplished in the way of road improvement by a small amount of effort intelligently applied.

There are a number of beds of a fairly good grade of peat in various parts of the county. One of these is traversed by the new line of the Great Western railway near the southwest corner of section 17, New Hampton township. The peculiar prominent boggy elevations, known as "mound springs," which are seen on many of the low slopes of Iowan drift, furnishing water which may be piped down to drier ground at lower levels, are all accompanied by accumulations of peat of greater or less extent. A small but typical mound spring, with its attendant bed of peat, occurs in the southwest ¼ of the southwest ¼ of section 33 within a few yards of the south line of Deerfield township. The largest amount of peaty material in one place, was seen in a bench which rises above the level of the valley gravels in the northeast ¼ of the northeast ¼ of section 32, Chickasaw township. Peat is probably of no value at present, but as fuel becomes scarcer and more

expensive, it may be profitable to briquette and dry the peat from some of the larger beds, and place it on the market.

Some small beds of limonite or bog iron-ore are found at a number of points in the county. None were seen of sufficient extent to justify their exploitation on a commercial scale. Probably the best known is that which occurs in the northeast ¼ of section 24, Dayton township.

Water Supplies.

Chickasaw county is well supplied with an abundance of pure, wholesome water. No area of similar size is better provided with streams, and a proportionately large part of the population depend on stream waters as a supply for farm stock. There are not many springs in the county compared with some other regions of our state, but well water of good quality is readily found on every farm. Most of the wells end in the drift, water being found either in seams in the glacial clays or in streaks of sand and gravel interbedded with the clays. In the broad stream valleys water is usually reached at depths ranging from twenty to thirty feet, in the beds of gravel belonging to the Buchanan substage. In a few instances wells penetrate the underlying limestones.

The farm wells about New Hampton are reported to end in a bed of water-bearing sand which lies immediately on top of the limestones, and the depth of the wells ranges from 125 to 160 feet. Eight or ten miles north of New Hampton, drillers report that wells go down 200 feet without striking rock. A depth of 200 feet is not infrequently reached in Dayton and Fredericksburg townships without penetrating the whole thickness of the drift. The town well of Lawler, in the valley of Crane creek, goes down through Buchanan gravel and Kansan clay to a depth of 135 feet. It is 137 feet deep and is reported to go into the rock only a foot or two. Wells on higher ground near Lawler show a thickness of 165 feet for the Pleistocene deposits, and go some distance below the level of the stream in the adjacent valley before encountering rock. In a well near Jerico the limestone was reached at a depth of 221 feet. The railway well at Ionia is 145 feet deep and ends in what is reported as "quicksand." The boring of deep farm wells has furnished reliable data concerning the surprising thick-

IOWA GEOLOGICAL SURVEY

GEOLOGICAL MAP OF CHICKASAW COUNTY IOWA.

BY

SAMUEL CALVIN

1903.

Scale 1:250000

1 ½ 0 1 2 3 4 5 Miles

1 ½ 0 1 2 3 4 5 Kilometers

LEGEND

GEOLOGICAL FORMATIONS

CEDAR VALLEY

INDUSTRIES.

QUARRIES

CLAY WORKS

LIME KILNS

Drawn and Engraved by The Huebinger Co. Davenport, Iowa.

ness of the great mantle of drift which overspreads nearly the entire county and effectually conceals the underlying rocks.

Shallow wells drawing supplies of water from the great gravel trains of the Buchanan age, are found in all the stream valleys. At Lawler, for example, water is obtained on any of the residence lots by simply driving points into the gravel to depths of from fourteen to sixteen feet. In the vicinity of Little Turkey post-office driven wells need go only twenty-five feet into the gravel beds to get unfailing supplies. In all the other stream valleys the situation is much the same.

At New Hampton the city well has a depth of 235 feet. The mantle of drift is 135 feet in thickness; the boring went 100 feet into the limestones. The well is ten inches in diameter; the water rises within thirty feet of the surface; the supply is ample to meet all demands so far made upon it. In the western part of the county some of the farm wells penetrate rock to greater or less distances.

Remains of the Aftonian forests, in the form of splintered fragments of wood worked up into the blue Kansan clay, are found in nearly all wells bored into the drift. Well drillers report that it is not unusual to strike a flow of gas at depths ranging from twenty to forty feet. No decisive tests relative to the quality of the gas have been made, but it is stated that at Bassett a lighted lantern was extinguished when let down into a well from which gas was escaping. It is quite probable that all the gas encountered in boring wells in the glacial deposits of this region consists largely or wholly of carbon dioxide.

Water Powers.

Considering the number of streams, there are not many water powers developed in the county. The water power on the Cedar at Nashua, and those at Chickasaw and Greenwood Mills on the Little Cedar are the most important.

SUMMARY.

Chickasaw county presented few features of interest to the older geologists. It was simply a great prairie plain traversed by numerous clear streams. The soils are exceptionally deep and

exceptionally fertile; but the very depth and the universal distribution of the mantle of loose materials have effectually concealed the quarry stones and other geological resources. Agriculture is, and must always remain, the most important industry of this county. There is building stone enough for all local needs in the few limestone quarries and in the universally distributed granite bowlders. There is some good lime burning rock available, and road materials, in the form of extensive beds of Buchanan gravels, are everywhere abundant. If any one regrets the absence of coal and other mineral products, let him remember the wealth producing qualities of the soils, which no right thinking man would exchange for the conditions favorable to mining; let him remember that the farms of Iowa are worth more than all the gold and silver mines of America.